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IMPLEMENTATION OF AN IOT BASED VEHICLE ACCIDENT DETECTION AND CLASSIFICATION SYSTEM USING SENSOR FUSION

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ABSTRACT:
According to Government of India, around 1,46,000 people [20] lost their lives in five hundred thousand of accidents, where 7% of lives could have been saved if they would have got medical attention before-hand. This can be achieved by intimating the accident information to the emergency unit in minimal time by using IoT based on the severity of accidents. In existing methods, the accidents are detected using On-based unit, and transmitted to the control unit using nearby antennas. where the severity of the accidents are classified using machine learning. Then the fetched data is compared with existing accident dataset which it is retrieved from previous accidents, the analysed results are then transmitted to the nearby emergency unit. This will lead to ambiguous prediction of data because if the data doesn't exist in the database, intensity of accident must be analysed manually in which it leads to increase in time complexity for transmitting the data to the nearby emergency unit due to intermediate infrastructure. To overcome these drawbacks, in this proposed system the accidents are detected using sensors and the severity of accident will be calculated using machine learning algorithms like linear regression and Support vector machine (SVM) classification under reinforcement learning with help of force and impact obtain while vehicle crashes, then the values are transmitted to the nearby emergency unit through IoT.
Keywords: Raspberry Pi, Machine learning, IoT, Sensor

1. INTRODUCTION

In present days, driving a vehicle is insecure (especially Two-wheeler) [2], [3] reasons being path-holes, rash driving, reckless driving. According to Government of India, around 1,46,000 people have lost their lives in accident, and in that around 7% of the victims had been died due to tarrying in admitting the victim to the nearest hospitals [20]. To reduce these types of causalities, many projects have been published. The existing works which are published in various journals can only prevent the accidents, but in few journals proposes
methods of reporting accidents to the nearby emergency unit using Automated systems. In this proposed work, sensors detect the accidents and classification of data is achieved using machine learning algorithms to find the severity of accident. After finding the severity it transmits the predicted severity to nearby emergency units. Sensors are used to detect the severity of accidents, hit of a vehicle.

Here SVM and linear regression under reinforcement algorithm is used for prediction the intensity of accident in which the real-time data are fetch as an unlabelled data using Raspberry pi and will be send to ThingSpeak IoT. Here Machine learning algorithm is implemented to prediction the severity. First the data set will be cluster into two-variant cluster data using linear regression algorithm and prediction will be done by classifying the data-point with clustered data using Support Vector Machine (SVM) classification algorithm [4]. The classified data is also called as predicted data. PIR sensor is used to detect whether the person is inside the vehicle or not with in-build facilities. The vibration sensor is used to detect the force and impact of the accident. The ultrasonic sensor is used to identify the object with which held in collision. The GPS receiver is used to track the accident location. The retrieving of data from sensor is done with the help of Raspberry pi. The accelerator is used to find whether vehicles are in motion or not and type of accident. In this work, the sensor data is transmitted through Wi-Fi using mobile data. In some cases, if the network doesn't exist or if the victim doesn't have mobile phone, then Ad-hoc network is used to transmit the data as given in [14], [23]. Ad-hoc network is a type of wireless network which does not rely on a pre-existing infrastructure. This Wi-Fi or Ad-hoc network acts as a medium to transfer data. This also transmits the location of Accidents.

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Camera is fixed in both rear and back side of vehicle which captures the image of hitting object which helps to solve hit and run cases. This work will be implemented in all type of vehicle including two-wheeler. The predicted data will be sending to nearby emergency unit

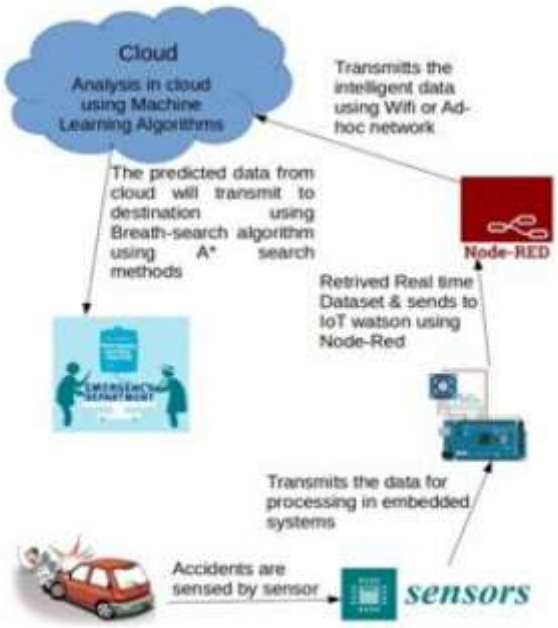

Figure 2. The architecture of the proposed works

According to the survey of published paper's, accidents are detected with the help of data mining as given in and severity of accident is measured. It means that the accident will be detected with the help of sensor and transmits through on-based unit (OBU) i.e. vehicular network through Antenna's which is placed near to accident spot and will be received by the control unit [5]. Real-time fetched data are compared with the accident dataset which is already stored in the database with help of previous accident data's using sequential pattern data mining and then the severity of accident will be confirmed. This will lead to long process of prediction and if the database doesn't contain previous data similar to recent data then the user's review will be considered. The main drawback of this work: Suppose if the data is unavailable in existing database, then the manual comparison of data takes place with the help of users. Since the data is compared with the previous accident data, in some cases this will lead to reporting of accidents unnecessarily In another project, the object detecting sensors are spatially distributed along the road to find the speed of the vehicle as given in [6]. These data are transfer to the neighbour sensor, if the two vehicles slow down at same rate which decides that accident takes place. The data are transmitted to control unit using wireless sensor network. This has a drawback that the cost of installation will be high and there is the chance of detecting false incident and this method won't be able to helpful to find the severity of accident. The accidents are also detected, and severity of accident is predicted using driver drowsiness which is also used to find accident based on behaviour of the driver as given in [3]. This work indicates that state of driver while driving. In case if the driver was in normal state but the accident occurs in which it has more probability to occur, in that case this proposed work will fail. This also has a drawback in that the accident will be predicted only based on drowsiness but not for other victims.

2. LITERATURE SURVEY

In this section different techniques for collision detection and reporting are discussed. Most of the systems focused primarily on mechanisms for accident detection, while some systems also focused on taking preventive measures to prevent accidents, so the strategies used to detect and prevent accidents are discussed separately.

ACCIDENT DETECTION TECHNIQUES

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Millions of people die in road accidents every year, most of the time accidents are not serious, but there is still a huge loss of life due to delay of emergency services. So a system capable of analysing a situation and able to detect it as an accident would be very helpful in providing timely assistance. Various strategies used to detect accidents are discussed in this section.

1) CONVENTIONAL ACCIDENT DETECTION TECHNIQUES

A: using vanet (vehicular ad-hoc network)

Manuja et al. [32] proposed that problems of traffic congestion arise due to vehicle failure or due to accidents in no network area. They proposed a system to solve this problem based on VANET. In this system every moving vehicle is considered as a node. The alert messages are transmitted using RF module, and alert messages are received by the moving vehicles that are in the range of RF module. Finally, the vehicle in the network area receives the message, then the received message is transmitted to the base station. The alert message contains four types of messages. These are detected by piezo electric sensor, MEMS (Micro-electro-mechanical systems) sensor, flame sensor, and temperature sensor. The system identifies vehicular mishap in considerably less time and alerts the rescue teams along with the location of mishap. A switch is also added in the system, which the driver can use to stop sending alert message in case when injuries are minimum or there's no serious loss. The controller gets the input from sensors and sends the accident alert information to the road side unit and then message is sent to the rescue team. WIFI and GPS are used to find the location of vehicle. In previous systems, GSM module failed to communicate in no network area, it'll provide coverage in network and no network area. A switch is also available to stop sending of message in case of no serious damage

B: using vibration sensors Tushara and Vardhini [33] proposed a solution for accident detection that uses a micro controller to control operations like detecting and reporting. The system focuses on minimizing the action time after an accident has occurred. A number is pre-fetched on the system, to which an alert is sent on occurrence of accident. The accident is detected using a vibration sensor. The system has high probability of generating wrong output because of its reliance on single sensor only. The weakness of the system is that it generates an alert message on occurrence of accident but accident location is not shared.

C: using piezoelectric sensors

Patil et al. [33] put forward a solution in which the system will sense accidents and will inform the nearest police station and rescue teams. GSM technology is used to communicate alert messages to the emergency services. The system continuously tracks the vehicle and can immediately alert the emergency services in case of any mishap. Renessa's microcontroller is used in conjunction with GSM modem and GPS receiver. GSM is used for communication purpose which sends an alert message containing the location which is provided by GPS. It's main modules consist of piezoelectric sensor, GSM and GPS. The system tracks the location continuously so in case of mishap the location is communicated timely. The primary drawback of this approach is that, no switch is available to cancel sending of alert messages in case of no serious damage, secondly location is continuously monitored, so it might drain a lot of battery.

D: using accelerometer sensors In [4] its discussed that, ''one fourth of the people involved in accidents are motorcyclists''. Rash and careless driving are the primary causes of causalities in bike riders. A system is proposed which uses helmet as an apparatus for accident detection and reporting. Sensors, processors and cloud computing infrastructure are used to build the system. On accident detection details are sent to the emergency contacts using Cloud based service. GPS tracks the location of vehicle. A GPS, microcontroller and a tri-axial accelerometer are present on the helmet. The probability of accident is calculated by continuously monitoring orientation of head and helmet's position. If the pre-fetched speed limit is exceeded, a text message as an alert is sent to the emergency contacts. The system on the helmet connects with the cloud server using RESTful architecture communicating through HTTP (Hyper Text Transfer Protocol). The system is cost effective as compared to other systems, also on occurrence of accident, text messages are repeatedly initiated until acknowledged. The major drawback of this approach is that there is a possibility of false alarm if the driver drops the helmet by mistake, additionally, more storage and computational capabilities are needed because the system needs to communicate with the cloud services.

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3. PROPOSED SYSTEM

In the proposed system, the accident is detected using proximity sensor, accelerometer and vibration sensor. When accident takes place, sensor detects the object in which sensors are placed in the vehicle. When the sensor detects the accident, then the signals are received by processor (raspberry pi) will be transmitted to User application via ThingSpeak for analysing the retrieved data and measuring the severity of accident. The cloud environment is used in this proposed system for the following advantages: scalability, reliability, more processing speed, almost unlimited storage as given in [7], [8]. In this proposed system, severities of accidents are measured by using force and impact of clash between two vehicle or vehicle-object [24],[25]. This force and impact are detected using vibration sensors. Severities of accidents are also measured using sensors, where the PIR sensor is used to detect whether persons are placed inside the vehicle or not. Severity of accident is processed in user application. Machine learning method in which the accident dataset is clustered and classified to find the severity of accident as given in [11], [12] with the help of reinforcement learning algorithm given in [26], [27] and then data will be transmitted to nearby emergency unit along with location details of accident, as referred in [13]. In this proposed system camera is installed in both front and rear side of vehicle to capture the image of the hitting object to solve crime accidents like hit and run when sensors detect. The proposed system also consists of ultrasonic sensor to detect obstacle and alert the driver to avoid accidents. The prototype of the proposed system is designed as robotic car which will run with DC Motors. The block diagram of proposed system is as shown in the following diagram fig3.1.

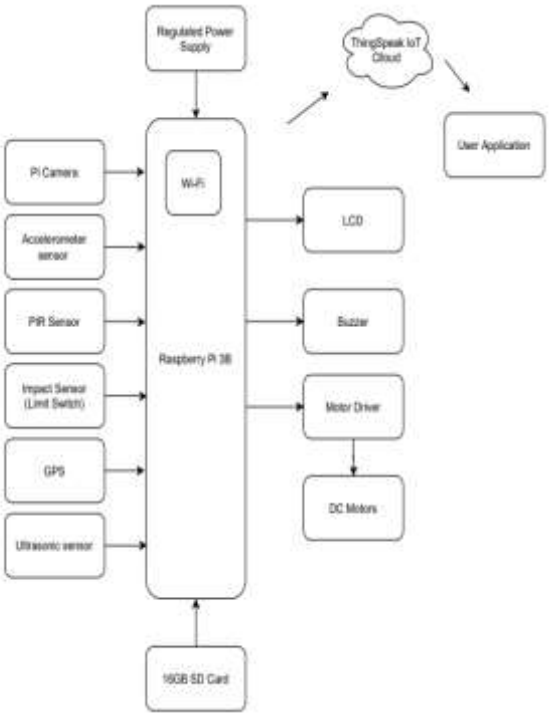

Fig3.1 Block diagram of proposed system

a. Detection of Accident

In this module, accidents are detected using sensors. Four Sensors are used to detect the accident they are impact sensor, PIR, accelerometer and ultrasonic sensor. In this work PIR sensor is used to detect whether person is placed inside the vehicle or not, if the person sited inside the car or not. Suppose, if the person sited inside then capacity of the car increases which will be detected by sensor. The impact sensor is a type of sensor which is used to detect the object vibration. impact sensor is used to detect the force and impact of the object. When the accident takes place the hitting of vehicle will have some force and produce some impact which will used to detect the severity of accidents. The ultrasonic sensor is a type of sensor which is used to detect the nearby object. Ultrasonic sensor is used to detect hitting object and activates the camera to find whether it is accident or criminal activity. The

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camera is placed in overhead of the vehicle to prevent from damage when a vehicle meets with an accident. After detecting the accident these sensors send the data to the single board processor called Raspberry pi which is used to transmit the data's as sender. Combining the sensors data and classifying them to find the severity of accidents as well as hit and run cases.

b. Transmission of Accident data

After detecting the accident using sensor, the data are transmitting through Wi-Fi network. Wi-Fi is a type of wireless connection used to transmit network connections as well as the data. Here in this module Wi-Fi is used to transmit the data of the accident through victims mobile where the raspberry pi will be connected to the victim's mobile using Wi-Fi.

c. Predicting Severity of accident using Machine Learning

To find the severity of an Accidents and impact of Accidents, machine learning concept [17], [18] is used to predict and analyse the severity of Accidents. When the real time data is fetched, by using reinforcement learning method as given in [15], [27] the data will be processed. Then the machine will be trained before testing by pre-processing method and then train the system. When data is fetched from hardware systems, it will be sent as a slice of window into engine where the data will be normalized to minimize the redundancy and clustered as given in [31] to find the range of data using linear regression algorithm and labelled. Then the clustered data will be classified using classification method Support Vector Machine as given in [18], [19] with labelled as low priority and high priority, then with the help of distance from hyper-plane classify the data and then prediction will be done. The severity of accident is calculated with help of force and impact of an accident crash with predicted data as given in [24], [25]. The system is trained with the pre-processed accident dataset in which the training will be done with the help of force and impact formula given below. The Force is detected by using the data in sensors, where the distance is measured using Ultrasonic sensor and velocity is found by vibration sensor and mass is calculated using load sensor [24], [25]. The Force is calculated using kinetic energy and work equal to W=K*E …. (1) Which is nothing but force and distance, that is equal to F= (0.5^m^ v^2)/d …. (2) and measured in Newton. In the above equation m is the mass of the object in which it detects by using load sensor, v is velocity measured by using Vibration and accelerator sensor and d is distance measured by ultrasonic sensor.

d. Reporting of Accident

In this module, accident data is transmitted to nearby emergency unit through IoT cloud. After predicting the severity of accidents, the predicted output data is transmitted as SOS messages to nearby hospitals, police station and Ambulance along with the locations as referred in [28], [29].

Table 1. Represent the format for retrieving Data from sensors

Threshold of Sensor Data	Yes	No
Person Inside or not	1	0
To check whether object inside is person	Value of measured weight of person	Nil
Vibration	N=1	N=0
Distance	Distance of an object	Nil
Accelerometer	Value of vibration	Nil

Table 1 represents the value of retrieved data from real time environment using sensors. In first row it describes the person inside or not, second and third is represents the vibration of the hit and distance. Accelerometer represents the weight of the vehicle, presence of person inside the vehicle and Hit speed of vehicle. This is used to find the fuzziness of the system [13], [29], especially to find sensing data which clarifies the existence of severity. This table represents the Predict values of sensor data where capacitive sensor which detects the presence of human inside the car and vibration sensor which detect the vibration of crash is binary dependent variable. Remaining sensors detect the unlabelled data.

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4. RESULT ANALYSYS

The proposed system was fully developed and tested to demonstrate its feasibility and effectiveness. The screenshots of the proposed system developed has been presented in Figures bellow.

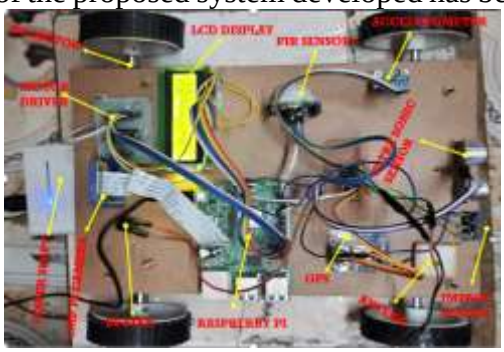

Fig 5.1 Experimental setup of proposed system

No	Sensor Name	Range Of Sensor Data	Severe Accident	Normal Accident	Remarks
1	PIR	PIR or PVAL :[0,1]	1	0	0-Person is Absent 1-Person is present
2	Limit or Impact	CRASH or CVAL:[0,1]	1	0	0-No Crash 1-Crash
3	Ultrasonic	OBS:<15 cm	Distance of an Object	Distance of an Object	Detected distance Value
4	Accelerometer	X:[0-9] Y:[0-9]	X:[0-9] Y:[0-9]	X:[0-9] Y:[0-9]	X-Horizontal Direction Value Y-Vertical Direction Value

Data from Sensors

Fig. LCD display When hardware prototype is initialised

Fig. Screenshot of Each sensor data displayed in python shell

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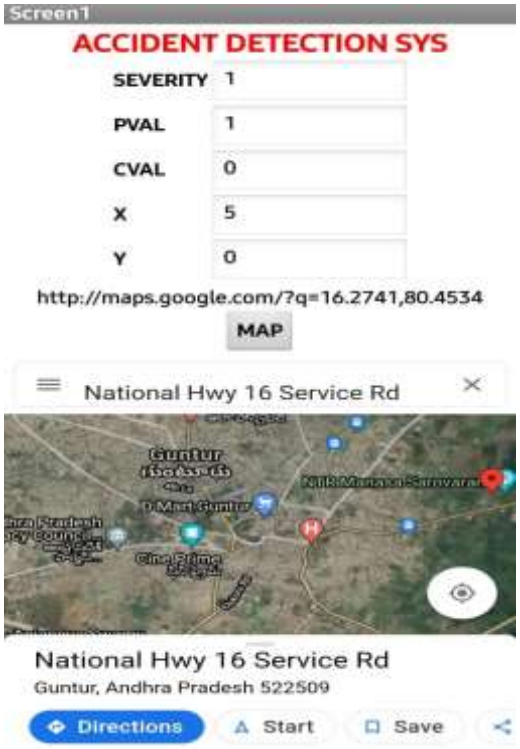

Fig. Mobile Application screenshot of accident detection values and location

5. CONCLUSION AND FUTURE WORKS

This work will reduce the number of deaths in accidents by reporting the incident to the nearest emergency unit at the earliest. This work will also be used to help police to find the crimes and hit-run cases. In Future, this work will be extended to indicate the driver about the possibilities of accident occurring by using machine learning and ensure the rate of speed of intimating the accident to nearby emergency unit will be increased along with victim's details. In Future, the exact location name will be detected and transmitted using Map. Entire insurance policy detail of people will be embedded into the system. The criticality of the accident with the patient details will be automatically sent to the insurance agency.

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